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ABSTRACT

A cooperative effort of 29 engineering colleges, Colorado's National Technological University (NTU) is designed to provide career-long engineering education through the use of educational television and teleconferencing. NTU delivers both graduate courses leading to Master of Science degrees and continuing education instruction via communications satellite to more than 242 sites nationwide, including corporations, government agencies, and colleges. Each NTU site is operated by a sponsoring organization, thus emphasizing the relationship between schools and business. The use of educational media in higher education and professional development has resulted in making a wide array of engineering educational services available to practicing engineers as well as engineering students and faculty. Moreover, the satellite delivery system has proved to be exciting and effective. NTU's domestic success has attracted worldwide attention, and international cooperation is being sought for the exchange of information and technical education. (5 references) (DB)

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THE NATIONAL TECHNOLOGICAL UNIVERSITY MEETS A WORLDWIDE NEED

BY

Bernard R. Sarchet and Lionel V. Baldwin

ABSTRACT

Engineering faculty in the United States have pioneered the use of instructional television (ITV). Today, practicing engineers have a much wider array of advanced educational services potentially available at their job sites than any other profession. Satellite delivery has added significantly to both diversity and accessibility.

The National Technological University today delivers instruction to more than 242 sites nationwide, including 60 corporations, 11 government agencies and 29 colleges. Over 5,400 technical professionals have completed graduate courses in the first three years of operation and 45,000 participated in short courses and tutorials in 1988-89. Annually, NTU offers 10,000 hours of graduate instruction and 1,200 hours of interactive continuing education and research teleconferences.

NTU is a cooperative effort of 29 major engineering colleges to provide high quality career-long education. Six technical programs of study leading to Master of Science degrees are awarded by NTU. A graduate program in Management of Technology began in fall, 1989.

NTU has a rapidly growing, loyal customer base who demand high quality instruction. The delivery technology is exciting and effective, but the cooperative effort to meet well defined goals is more critical to success.

NTU's domestic success is attracting worldwide attention. More than twenty countries and organizations have made contact. Discussions are underway in several situations. Active relationships are anticipated in the coming years.

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THE NATIONAL TECHNOLOGICAL UNIVERSITY MEETS A WORLDWIDE NEED

BY

Bernard R. Sarchet[1] and Lionel V. Baldwin[2]

No one university can meet the demand for the variety of continuing education coursework required by engineers today. In August, 1974, representatives from two dozen U.S. colleges operating video-based programs, along with a sample of their customers, attended a workshop to discuss ways in which cooperation might improve continuing education service. Follow-up planning in April, 1976, led to the formation of a non-profit consortium, the Association for Media-based Continuing Education for Engineers (AMCEE). Initially, twelve schools adopted the goal "to increase the national effectiveness of continuing education for engineers." The first AMCEE catalog, published in 1978, contained 172 courses from ten universities; the current catalog lists more than 280 courses from 30 schools in 14 engineering disciplines plus the consortium itself. Member universities in AMCEE have grown from 12 in 1976 to 33 schools today. Thousands of engineering and technical professionals from industry and government use AMCEE videotape courseware each year [Ref. 3 and 4].

The introduction of modern telecommunications to support shared advanced instruction for technical professionals nationwide has had a broad and lasting impact on U.S. higher education. In a recent study of education in corporate American, Nell P. Eurich [Ref. 1] concluded that "engineers seem to be light years ahead of other professions in using media for education and updating." So it is natural that engineering and computer science faculty were the first to explore satellite delivery.

A SATELLITE NETWORK FOR ENGINEERING ITV

By the early 1980's, AMCEE was filling many needs in graduate engineering education. The consortium's success strongly suggested that a place existed for a national university that taught students through the latest telecommunications technologies. With increasing affordability of satellite

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communications, AMCEE's Board of Directors saw the possibility of extending the range of ITV systems to a coast-to-coast audience. Since less than half the engineering work force was served by regional systems, there clearly was a role for satellites to play.

The universities in AMCEE believe that the cooperative approach is the best way to meet the demand for quality graduate and continuing education instruction. In February, 1982, the AMCEE Board of Directors agreed to investigate the feasibility of creating a national engineering college that would deliver its programs through the most advanced satellite telecommunications technologies. The network would be shared by the universities and sponsors such as industry and government laboratories. The Board pledged $100,000 of consortium funds to the study. Fourteen industrial and Department of Defense sources added $370,000 to the planning effort. These sponsors provided technical advice and met regularly to help shape the plan over a two-year period.

THE NATIONAL TECHNOLOGICAL UNIVERSITY

The National Technological University was established in Colorado as a separate non-profit, private educational corporation in January, 1984. NTU was created to award masters degrees in selected fields. The academic programs feature approved courses of instruction offered by its 29 participating universities, all members of AMCEE.

The consortium, in consultation with the sponsors, constructed the NTU network for Ku-band transmission. East participating university is equipped with an uplink for transmission as well as a received [Fig. 1]. These installations cost about a quarter of the more familiar C-band installations. Even more importantly, Ku-band uplinks can be placed on roofs (4.5 m dish) in metropolitan campuses such as the University of Minnesota and Northeastern University. The Ku frequency band is not used for terrestrial microwave and, therefore, requires no interference study before siting uplinks or receivers. These factors have led increasingly to the development of internal networks within corporations at the higher frequency.

The NTU satellite network was the first to operate two full-motion, color ITV channels on a single transponder. The 54 MHz transponder is split into two 22 MHz independent channels. Since August, 1985, GSTAR 1, transponder 5, at 103 degrees west longitude has provided the space segment of the network. In January, 1989, NTU began operating four channels of ITV when it leased transponder 8 in addition to 5.

By using advanced educational and telecommunications technology to deliver instructional programs to graduate technical professionals at their employment locations, students do not need to leave the workplace to participate in the instructional programs. Each participating university evaluates and records grades for students completing its courses. The student grades are also posted by the NTU Registrar at the end of each term.

Each NTU site is operated by a sponsoring organization (i.e., the company employing the student) following guidelines provided by NTU. The courses are rigorous, but provide a convenient and flexible alternative to campus study. NTU has the services of over 4400 full time engineering and computer science faculty members from participating universities, assuring high quality instructional programs. Moreover, NTU conducts research in areas of educational technology related to teaching and learning to insure continued responsiveness to the needs of the students [Ref. 1].

NTU's functions are to:

- Award master's degrees to qualified individuals in selected disciplines;
- Provide research seminars in each discipline;
- Operate a modem telecommunications delivery system for convenient, flexible, on-site service;
- Offer non-credit short courses, tutorials, seminars and research symposia to introduce newly advanced technology concepts to a broad range of technical professionals; and
- Establish a sophisticated satellite network infrastructure between industry and the university communities.

NTU began offering courses to more than 150 technical professionals in the Fall of 1984. Programs were distributed by video cassette. This first group of adult learners were employed at 14 sponsoring sites of Eastman Kodak, H-P, IBM, GE and NCR. Six universities taught 15 courses of the Computer Engineering graduate program. On August 28, 1985, NTU began satellite delivery and enrollments jumped dramatically [Fig.2]. In Spring, 1989, 23 universities delivered 88 courses to over 1,300 enrollees from 56 corporations and 11 government agencies listed in Table 2. NTU ceased shipping cassettes in May, 1985.

The NTU network is configured so that by summer, 1989, each instructor can simultaneously teach both on- and off-campus students. Specially equipped ITV classrooms, each with several remotely controlled color cameras and audio microphones, are the origination point of each broadcast. The ITV signal can be beamed instantly from each of the 29 campuses to the satellite. fig. 1 is a schematic of the satellite ITV system. The part-time students at their job sites can view the class live and, through telephone linkages, ask questions during the class session.

The interaction in a teleconferencing mode via satellite has been successful. Since the NTU credit classes are planned to serve an average of 40 off-campus students, classroom interaction between the teacher and off-campus students can be easily accommodated. For classes that must be delayed a few hours before being broadcast because of schedule conflicts, NTU provides occasional time for recitation sessions done by teleconferencing. Videotape machines offer the student who must miss a session the opportunity to view it at a later, convenient time. Indeed, videotape is an essential part of all live ITV today--it adds a time buffer when needed as well as an opportunity for review.

Each receiving site is equipped by the sponsoring organization with a TV receive-only station (TVRO). These installations generally cost less than 410,000 and consist of a 3.6 meter antenna or dish (larger in some areas) with surface tolerance sufficient for Ku-band reception, plus two low-noise amplifiers or block downconverters and two tunable video-audio demodulators or receivers. Color monitors and several programmable 1/2 inch VHS record/players complete the receiving station equipment which is often located in small, multi-purpose conference rooms at the corporate sites. The number of receive sites has grown rapidly [Fig.3].

Each receiving site pays an access fee to join the NTU network. Some corporations choose to pay a corporate side fee, allowing all their U.S. locations to participate.

After the receiving site joins the network, each enrollee is charged tuition and fees for each course taken. Each participating university sets the tuition for the instruction it provides in the NTU program. This tuition may vary from school to school. With the exception of two universities, tuition and fees in 1988-89 are $385 per semester credit hour and $285 per semester audit hour.

NTU currently offers programs of study leading to the Master of Science degree in five disciplines. Students can choose from 508 approved courses in the 1988-89 **Academic Bulletin** in Computer Engineering, Computer Science, Engineering Management, Electrical Engineering and Manufacturing Systems Engineering. Curricula are regularly reviewed; new classes are added each year and some courses are revised or dropped. To conduct the academic functions, NTU relies upon a graduate faculty of consultants selected from the instructors of each participating institution.

NTU is accredited by the Commission of Institutions of Higher Education of the North Central Association of Colleges and Schools.

In fall, 1989, NTU began offering a new program of study leading to an M.S. in Materials Science and Engineering. NTU initiated a graduate program in the management of technology with the first class of individuals accepted in August, 1989. A two-year program of half-time study at the job site via ITV, plus 7 one-week resident classes are planned. NTU will select the best instructors and

courses and, via its nationwide satellite ITV network, provide a carefully coordinated, high quality program of study leading to a Masters degree in the Management of Technology. both university and non-academic sources such as consulting organizations and government will be involved. The students will be drawn from young middle-managers nominated by NTU sponsoring corporations as having a high probability of advancing into senior corporate management during their careers.

PROGRAM EVALUATION

During the first week of class, each student received a personal welcome letter from NTU along with a self-addressed, stamped return postcard. The return card is an early evaluation of video, audio and camera-work quality. "Are the lectures correctly identified? Did you receive the course syllabus, book, and supporting handouts?" Almost half of the students return these cards, providing an "early warning" system. Faculty and ITV program administrators are sent the tabulated results and individual cards immediately. The actual mechanics from classroom-to-classroom are thereby evaluated for each course at each site each term. Problems are worked out early.

The principle problem which students report is the great time commitment required to complete the graduate classes. Virtually all students must maintain their regular job and family commitments, and squeeze in their graduate study. Furthermore, since most left college 5 to 10 years before starting NTU studies, they report that they must regain their study skills.

How do the employers evaluate NTU? Since the number of sponsoring sites and corporations is growing rapidly, the bottom line must be good.

One corporation's internal evaluation concluded, "There are many advantages to NTU. NTU has a large and varied offering of courses. These are of high quality content and are presented by very skillful professors. As a taped format, courses are flexibly accessed and allow a person to review the course material on their own as needed. NTU offers a variety of specialized courses not found at a single university. NTU allows many people who could not otherwise do so to pursue advanced studies at home and at work."

SHARED NATIONWIDE ITV NETWORK

The time period from 11:00 am to 5:00 pm EST on Channel B is reserved for non-credit, short courses, tutorials, seminars, research symposia and teleconferences. These are all offered live and interactively. Approximately 180 days of this special programming is delivered annually. Over 45,000 attended these programs in 1988-89; a five-fold increase over the previous year.

Since April, 1987, this career-long education program, which we call Advanced Technology & Management Program, has been organized into three regular series:

- Technical Professional Development Series -Two hours each Monday are devoted to increasing personal and organizational skills of technical professionals. Speakers are drawn from industry, consulting and universities. A different topic is offered each month.

- Monthly Feature - Third Tuesday and Wednesday of each month is devoted to a topic of current interest. Most are tutorials, but some are research symposia. Speakers are leading authorities from government, industry, consulting and universities.

- Member's Choice - The remainder of each month is devoted to a one-, two-, or three-day (rarely four) tutorial, research symposium, or teleconference. As the name implies, these are usually produced by the 29 consortium member universities who participate in the non-credit operation.

Today, these programs are attracting 700-900 attendees at 50-60 sites. Videotapes may be made and used for a 30-day period. Each program is supported by a set of notes and visuals delivered at least two weeks prior to the broadcast.

INTERNATIONAL COOPERATION

A recent report by the National Academy of Engineering entitled "Strengthening U.S. Engineering Through International Cooperation" argues that the U.S. has much to learn from other nations and urges that:

"Better focused and improved U.S. efforts are needed for:

1. Promoting international cooperation in engineering research;

2. Making U.S. engineering education more responsive to worldwide progress and concerns;

3. Gathering, disseminating, and assimilating information from abroad; and

4. Supporting international organizations and standards." [Ref.5]

The NTU Board of Trustees has insisted that any foreign project not threaten the viability of the current program in the United States and Canada. In addition, they feel that NTU should seek long-term relationships that can lead to the exchange of information and technical education.

A committee of eight (four from participating universities and four from sponsoring corporations) meets quarterly to guide NTU in this area. Since 1984, NTU has hosted many foreign visitors, corresponded with others and participated in numerous international conferences. More than twenty different countries have expressed interest in working with NTU [Table 1].

The appropriate role for telecommunications in linking technical professionals worldwide is only now evolving. But, we can expect progress to be rapid, and that NTU will play a significant role.

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TABLE 1

PARTIAL LIST OF NTU INQUIRIES ON INTERNATIONAL COOPERATION

AIT (Asian Institute of Technology)
Australia Educational Media
Columbia
Dominican Republic
EUROPACE
ITESM, Monterrey, Mexico
Itoh (Japan)
Learning Network Corporation (South Africa)
Nacional de Telematica (Brazil)
Norwegian Institute of Technology
Saudi Arabia
SCC (Space Communications Corp.-Japan)
Singapore
South Korea
University of Hagen (Germany)
University of Linkoping (Sweden)
University of Puerto Rico
University of West Indies
Venezuela

NTU SITES

TABLE 2

Advanced Micro Devices, Inc.
- Austin, TX
- San Antonio, TX

AG Communications
- Phoenix, AZ

Air Products and Chemicals, Inc.
- Allentown, PA

ALCOA
- Alcoa, TN
- Alcoa Center, PA
- Davenport, IA
- Pittsburgh, PA
- Rockdale, TX

Allied Signal Aerospace Company
- Kansas City, MO
- South Bend, IN

Analog Devices, Inc.
- Greensboro, NC

Armco, Inc.
- Ashland, KY

Atmel
- Colorado Springs, CO

AT & T
- Allentown, PA
- Golden, CO
- Hopewell, NJ
- Lisle, IL
- Little Rock, AR
- Mesquite, TX
- Middletown, NJ
- Norcross, GA
- North Andover, MA
- Phoenix, AZ
- Pleasanton, CA
- Reading, PA
- Shreveport, LA
- Skokie, IL
- Union, NJ
- Westminster, CO

The BDM Corporation
- Albuquerque, NM

Bellcore
- Piscataway, NJ

Boeing Aerospace Company
- Seattle, WA

Boeing Military Airplane Co.
- Wichita, KS

Booz-Allen & Hamilton, Inc.
- Bethesda, MD

Bull HN Info. Systems, Inc.
- Billerica, MA
- Phoeniz, AZ

Burle Industries, Inc.
- Lancaster, PA

College Center for the Finger Lakes
- Corning, NY

CTS Corporation
- Berne, IN

A Dallas-Based Info. Management Co.
- Plano, TX
- Southfield, MI

Deere & Company
- Moline, IL

Department of Defense
- Griffis AFB, NY

Naval Development Center
- Warminster, PA

Naval Avionics Center
- Indianapolis, IN

Naval Research Laboratory
- Orlando, FL
- Washington, DC

Naval Weapons Support Center
- Crane, IN

U.S. Army (ARDEC)
- Picatinny Arsenal, NJ

U.S. Army Engineer District
- Rock Island, IL

U.S. Army Intelligence Ctr & School
- Fort Huachuca, AZ

Department of Energy

Lawrence Livermore National Lab.
- Livermore, CA

Digital Communications Associates, Inc.
- Alpharetta, GA

Digital Equipment Corporation
- Andover, MA
- Augusta, ME
- Boxboro, MA
- Colorado Springs, CO
- Cupertino, CA
- Greenville, SC
- Hudson, MA
- Littleton, MA
- Marlborough, MA
- Maynard, MA
- Nashua, NH
- Shrewsbury, MA
- South Burlington, VT
- Stow, MA
- Tempe, AZ
- Tewksbury, MA

Eastman Kodak Company
- Kingsport, TN
- Rochester, NY
- Windsor, CO

E.I. du Pont de Nemours & Company
- Aiken, SC
- Decpwater, NJ
- Memphis, TN
- Newark, DE
- Orange, TX
- Parlin, NJ
- Wilmington, DE

General Dynamics Corporation
- East Camden, AR

General Electric Company
- Bridgeport, CT
- Cincinnati, OH
- Daytona Beach, FL
- Erie, PA
- Florence, SC
- Lynchburg, VA
- Lynn, MA
- North Clarendon, VT
- Plainville, CT
- Schenectady, NY (2 sites)
- Utica, NY
- Wilmington, NC

General Instrument Corporation
- Hatboro, PA
- Hicksville, NY
- Hunt Valley, MD
- Nogales, AZ
- San Diego, CA

Georgia Tech. Research Institute
- Macon, GA

GTE Corporation
- McLean, VA
- Phoenix, AZ
- San Angelo, TX
- Waltham, MA

Harris Corporation
- Quincy, IL

Hewlett-Packard Company
- Andover, MA
- Avondale, PA
- Boise, ID
- Colorado Springs, CO (3 sites)
- Corvallis, OR
- Cupertino, CA
- Everett, WA
- Fort Collins, CO
- Greeley, CO
- Loveland, CO
- McMinnville, OR
- Mountain View, CA (2 sites)
- Palo Alto, CA (5 sites)
- Rockaway, NJ
- Rohnert Park, CA
- Roseville, CA
- San Diego, CA
- San Jose, CA (2 sites)
- Santa Clara, CA
- Santa Rosa, CA
- Spokane, WA
- Sunnyvale, CA
- Vancouver, WA
- Waltham, MA

Honeywell, Inc.
- Brooklyn Park, MN
- Clearwater, FL
- Denver, CO
- Edina, MN
- Everett, WA
- Freeport, IL
- Glendale, AZ
- Golden Valley, MN (2 sites)
- Hopkins, MN
- Minneapolis, MN (2 sites)
- Phoenix, AZ
- York, PA

IBM Corporation
- Boca Raton, FL
- Boulder, CO
- Bromont, Quebec, Canada
- Endicott, NY
- Essex Junction, VT
- Fishkill, NY
- Gaithersburg, MD
- Houston, TX
- Kingston, NY
- Owego, NY
- Poughkeepsie, NY
- Research Triangle Park, NC
- San Jose, CA (2 sites)
- Thornwood, NY
- Tucson, AZ

Illinois Institute of Technology
- Chicago, IL

Industrial Management Council
- Rochester, NY

Industry Education Council of Santa Clara County
- San Jose, CA

Intel Corporation
- Chandler, AZ
- Folsom, CA
- Hillsboro, OR
- Rio Rancho, NM
- Santa Clara, CA

Kerr-McGee Corpration
- Oklahoma City, OK

Magnavox Government & Industrial Electronics Company
- Ashburn, VA
- Fort Wayne, IN

Martin Marietta Corporation
- Bethesda, MD
- Denver, CO
- New Orleans, LA
- Piketon, OH

Mason & Hange
- Amarillo, TX

McDonnell Aircraft Company
- St. Louisk MO

Mead Data Central, Inc.
- Miamisburg, OH

Microchip Technology, Inc.
- Chandler, AZ

Micron Technology, Inc.
- Boise, ID

Milliken & Company
- Spartanburg, SC

Mine Safety & Health Administration
- Triadelphia, WV

The MITRE Corporation
- Bedford, MA
- McLean, VA

Motorola, Inc.
- Arcade, NY
- Arlington Heights, IL
- Austin, TX
- Fort Wroth, TX
- Northbrook, IL
- Schaumburg, IL
- Seguin, TX

NASA
- Hampton, VA

National Semiconductor Corporation
- Puyallup, WA
- Santa Clara, CA
- South Portland, ME
- Tucson, AZ
- West Jordan, UT

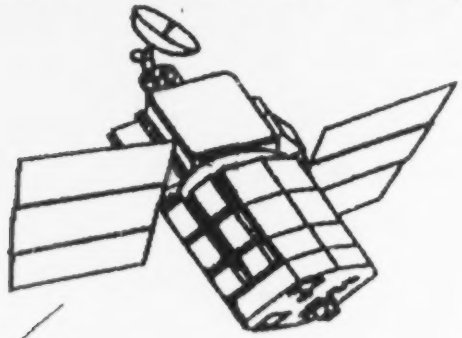
NCR Corporation
- Cambridge, OH
- Colorado Springs, CO
- Dayton, OH (2 sites)
- Fort Collins, CO
- Hauppage, NY
- Ithaca, NY
- Lake Mary, FL
- Liberty, SC

NCR Corporation (Continued)
Miamisburg, OH
Norcross, GA
San Diego, CA (2 sites)
Saint Paul, MN
Waterloo, Ontario, Canada
West Columbia, SC
Wichita, KS (2 sites)
Pacific Bell
Pasadena, CA
Sacramento, CA
San Ramon, CA
Perkin-Elmer Corporation
Norwalk, CT
Polaroid Corporation
New Bedford, MA
Quintron Corporation
Quincy, IL
Rockwell International Corporation
Cedar Rapids, IA
SRI David Sarnoff Research Center
Princeton, NJ
Southern NJ Tech. Consortium
Brick Computer
Brick, NJ
Cherry Hills Industrial Site
Cherry Hills, NJ
FAA Technical Center
Atlantic City, NJ
PSE & G. Nuclear Training Center
Salem, NJ
Tektronix Consolidated
Beaverton, OR
Grass Valley, CA
Wilsonville, OR
Texas Instruments, Inc.
Abilene, TX
Colorado Springs, CO
Dallas, TX (2 sites)
Lubbock, TX
Sherman, TX
Temple, TX
3M Company
Hutchinson, MN
St. Paul, MN
The Travelers Insurance Company
Hartford, CT
U.S. Bureau of Mines
Pittsburgh, PA
U.S. Government Agency
Washington, DC
U.S. WEST Advanced Tech., Inc.
Englewood, CO
Vitacom Corporation
Mountain View, CA
Whirlpool Corporation
Benton Harbor, MI
Winona State University (IBM Corp.)
Rochester, MN
Xerox Corporation
El Segundo, CA
Webster, NY

Date Printed October 20, 1989

Figure 1 - NTU SATELLITE NETWORK

GTE Spacenet - GSTAR I - Transponder 5



Range: Nationwide

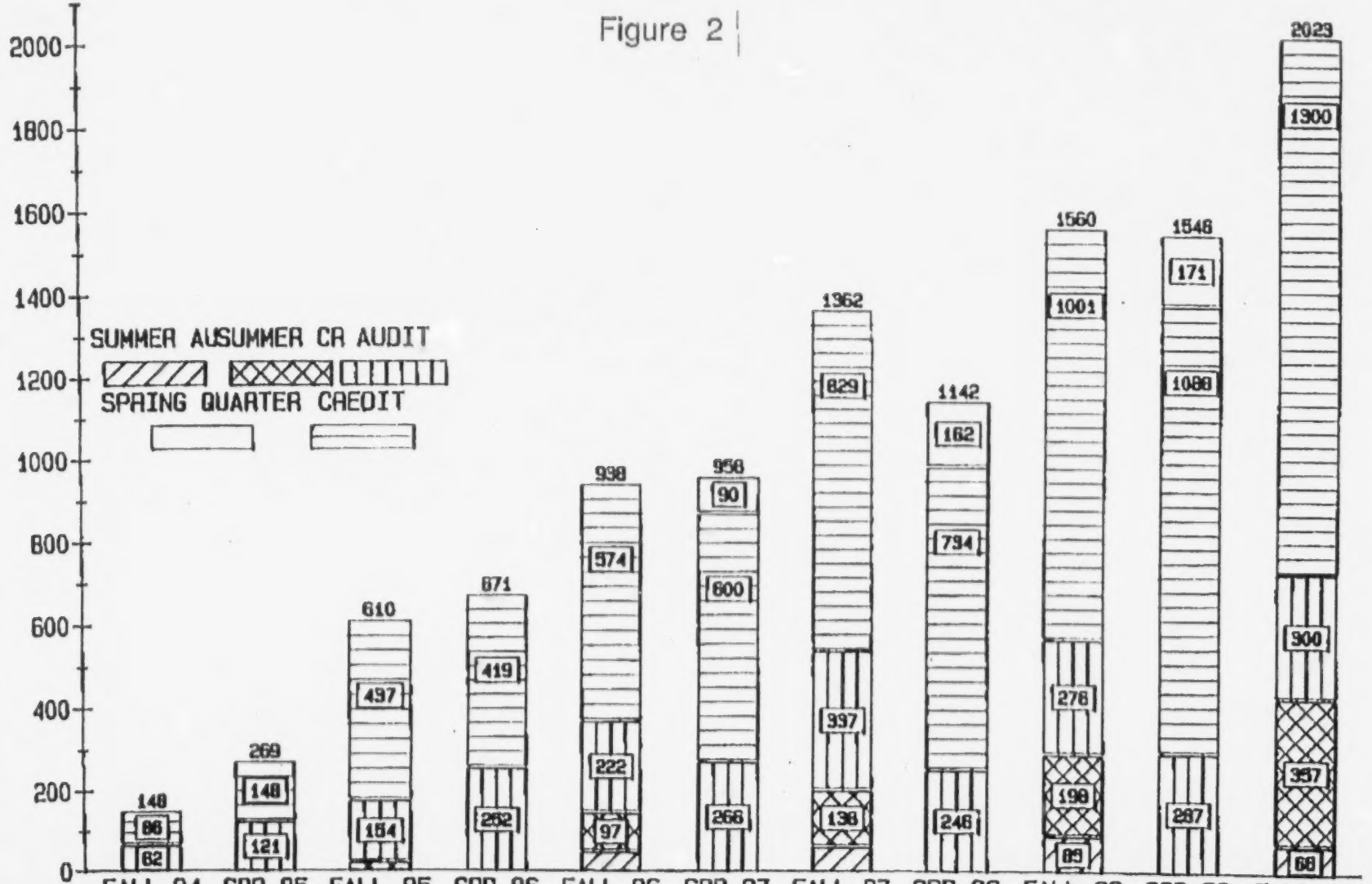
16 Fixed University Uplinks
6 Steerable University Uplinks
3 Mobile University Uplinks
4 Private Sector Uplinks

243 Earth Stations
at Industrial Sites

10/25/89 09:47 ☎303 484 0668 NATL TECH UNIV ☎014

ENROLLMENT SUMMARY

Figure 2



10/25/89 09:19 303 484 0668 NATL TECH UNIV 015

NTU RECEIVE SITES

Ku BAND

Figure 3